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Mechanism of Grid Power Loading in Electro-Static Accelerator with Multiple Apertures and Acceleration Stages for ITER

Junichi Hiratsuka, Masaya Hanada, Atsushi Kojima, Naotaka Umeda, Mieko Kashiwagi, Masafumi Yoshida, Ryo Nishikiori, Masahiro Ichikawa, Kazuhiro Watanabe, Hiroyuki Tobari, and NB Heating Technology Group

Japan Atomic Energy Agency, Naka, Japan

Corresponding Author: Junichi Hiratsuka, e-mail address: hiratsuka.junichi@jaea.go.jp

In order to design the ITER negative ion accelerator, where the D^- ion beams of 40A are accelerated up to 1 MeV for 3600 s, power loading and localized power density on the acceleration grids are serious problems for long pulse accelerations. The past calculation results suggested that the power loading of the acceleration grids was caused by the over-focus of the negative ions in the extraction grid [1]. Tail of the negative ion is over-focused by strong converged electric field at the edge of aperture of the extraction grid and intercepted with the acceleration grids located in downstream. In order to reduce the over-focused ions, the trajectory of the negative ions was optimized by enlarging apertures of the extraction grid. This solution has been experimentally confirmed, where the power loading of the acceleration grid was reduced from 13% to 10% of the beam power. Moreover, the power density profile was estimated by a detailed calculation with a 3D simulation code. The results showed that the peak power density around the apertures of ground grid was reduced from 18MW/m^2 to 7MW/m^2 for 1MeV beam acceleration, suggesting that suppression of the converged electric field at the edge of aperture of the extraction grid also contribute to the reduction of the peak power density.

References

[1] J. Hiratsuka, M. Hanada *et. al.*, Plasma Fusion Res. **10**, 3405045 (2015).